

**Real-Time Systems**

<http://swt.informatik.uni-freiburg.de/teaching/SS2013/rtsys>

Exercise Sheet 4

Early submission: Tuesday, 2013-06-18, 10:00 Regular submission: Wednesday, 2013-06-19, 10:00

**Exercise 1: Playing with Definitions [2] (10/20 Points)**

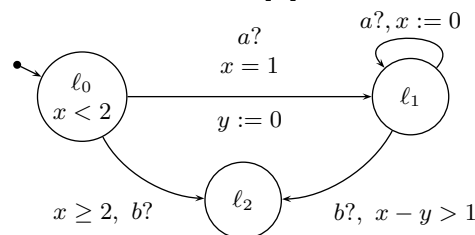


Figure 1: Timed Automaton for Exercise 1.

Consider the timed automaton  $\mathcal{A}$  in Figure 1.

- (i) Give the abstract syntax corresponding to the graphical representation of  $\mathcal{A}$ . (1)
- (ii) Propose a formal definition of Zeno behaviour.  
According to your definition: Does  $\mathcal{A}$  have a computation path with Zeno behaviour? (2)
- (iii) Propose a formal definition of timelock.  
According to your definition: Does  $\mathcal{A}$  have a computation path with a timelock? (2)
- (iv) Does  $\mathcal{A}$  have a run? (2)
- (v) Is the location  $\ell_1$  reachable? And  $\ell_2$ ? (3)

*Note: And usual, don't just state "yes" or "no" but convince your tutor of your claim by referring to the definition(s) relevant for the task.*

**Exercise 2: Playing with Uppaal<sup>1</sup> (10/20 Points)**

Consider the Off/Light/Bright example from the lecture (Lec. 11, Slides 4-7).

- (i) Provide an UPPAAL model for the system presented in the lecture. (3)
- (ii) Does your model  $\mathcal{M}$  have a run  $\xi$  such that

$$\xi \models_0 [\text{Off}]; ([\neg\text{Off}] \vee []); [\text{Bright}]; [\text{Off}]; ([\neg\text{Off}] \vee []); [\text{Bright}]$$

Use the simulator to provide a trace demonstrating this fact. (4)

- (iii) Modify (only) the user model to resemble a typical computer scientist: he considers bright lights irritating. The user should make sure that the Bright location is never reached. (3)

*Note: Please provide all Uppaal files that are necessary to confirm your results: The models for tasks (i) and (iii) and the trace files for task (ii).*

**Exercise 3: Playing with Theory (5 Bonus)**

Note that we used quotation marks to enunciate the property on exercise 3, task (ii), this is because the quoted mathematical expression has an intuitive meaning but we don't have a formal semantics for it.

Explain why, what is missing? What needs to be done to be allowed to remove the quotation marks? Do that.

<sup>1</sup>UPPAAL is installed in the pool, e.g. on [login.informatik.uni-freiburg.de](http://login.informatik.uni-freiburg.de).

## References

- [1] Gerd Behrmann, Alexandre David, and Kim G. Larsen. A tutorial on uppaal 2004-11-17. Technical report, Aalborg University, Denmark, November 2004.
- [2] Ernst-Rüdiger Olderog and Henning Dierks. *Real-Time Systems - Formal Specification and Automatic Verification*. Cambridge University Press, 2008.